

# **LZ dark matter detector**

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on behalf of LZ collaboration

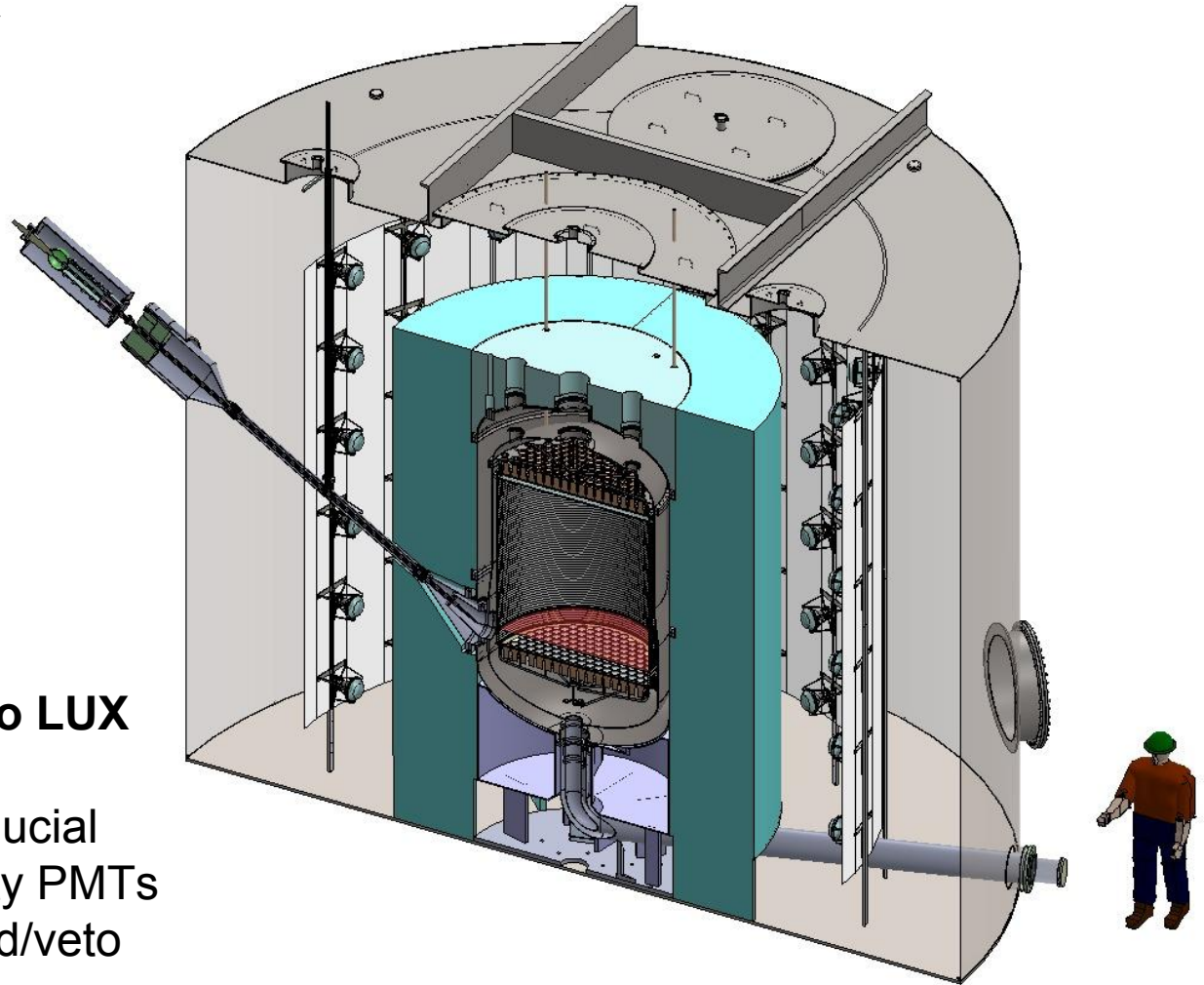
# LZ detector

**LZ = LUX & ZEPLIN**

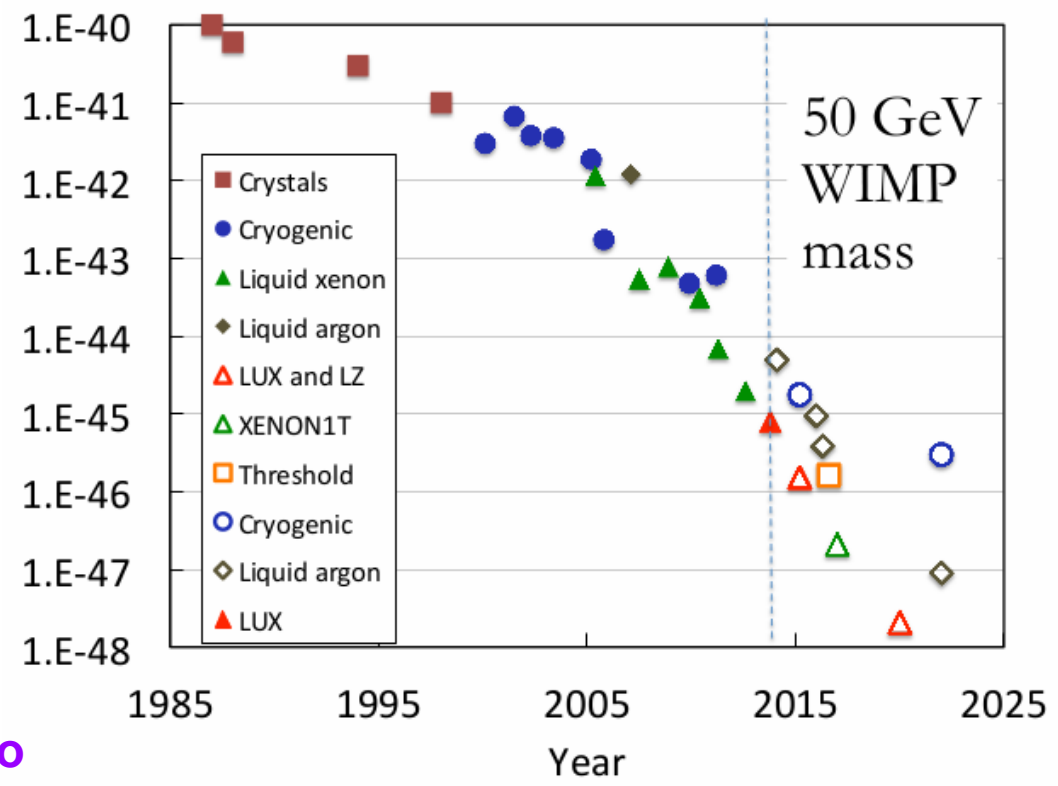
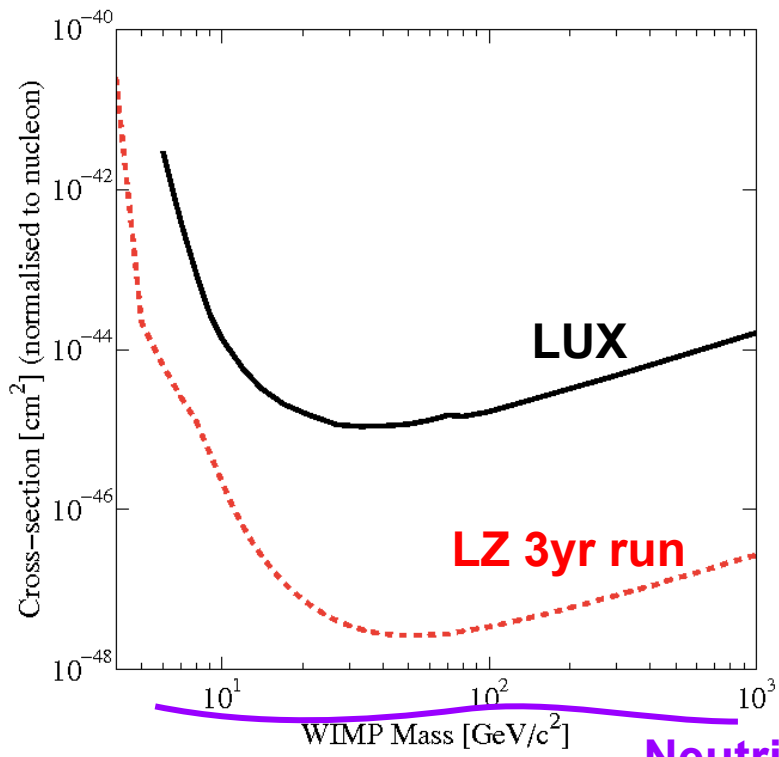
R&D started: 2011

## New features compared to LUX

- More Xe: 7t total, 5t fiducial
- 3" ultra-low radioactivity PMTs
- Liquid Scintillator shield/veto
- Instrumented "dead" Xe space
- Improved Cherenkov veto coverage



# Expected sensitivity



Neutrino background

# Collaboration

## 19 US Groups

Brookhaven National Laboratory  
Brown University  
Case Western Reserve University  
LLNL  
SLAC  
SD School of Mines and Technology  
SD Science and Technology Authority  
Texas A&M University  
University Of Alabama  
University of California, Berkeley/LBNL  
University of California, Davis  
University of California, Santa Barbara  
University of Maryland  
University of Rochester  
University of South Dakota  
University of Wisconsin  
Physical Sciences Laboratory, Wisconsin  
Washington University  
Yale University

## 9 European Groups

Imperial College, London  
**LIP – Coimbra**  
Moscow Engineering Physics Institute  
Oxford University  
STFC Daresbury Laboratory  
STFC Rutherford Appleton Laboratory  
University College, London  
University of Edinburgh  
University of Sheffield

# Timeline

- LZ proposal/R&D report submitted to DOE & NSF in **Nov 2013**
- DOE & NSF conducting down select process; **decision due May/June 2014**. Meanwhile, LZ Collaboration works on concept design report (CDR)

## **If we are selected:**

- CDR and critical decision (CD-1) review expected **Fall 2014**
- CD-1 approval ~ 60 days after a successful CD-1 review

## **Provided successful CD-2 and CD-3, we expect:**

- Fabrication to start **late 2015**
- Detector installation in Davis **early in 2017**
- Data taking start **early 2018**

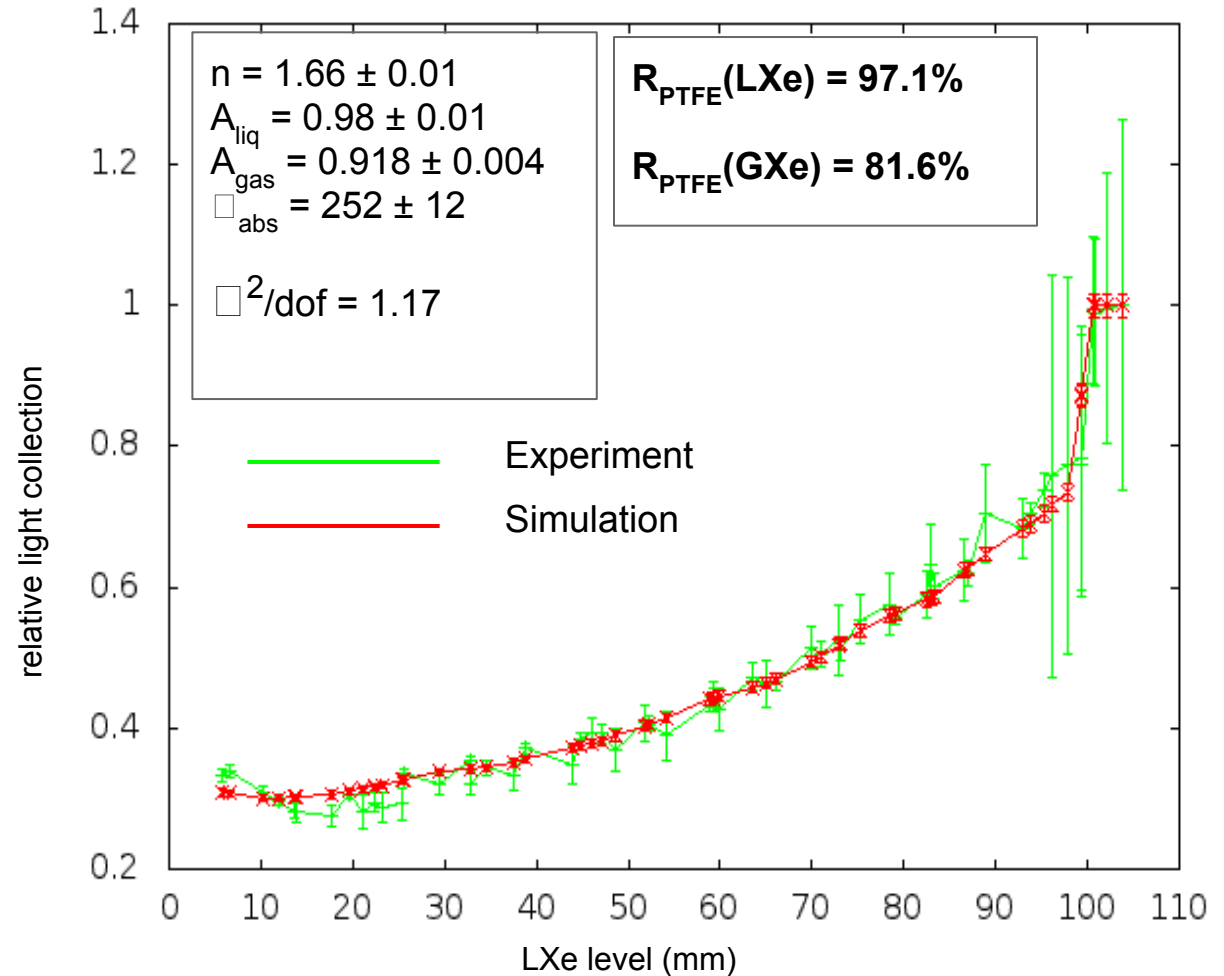
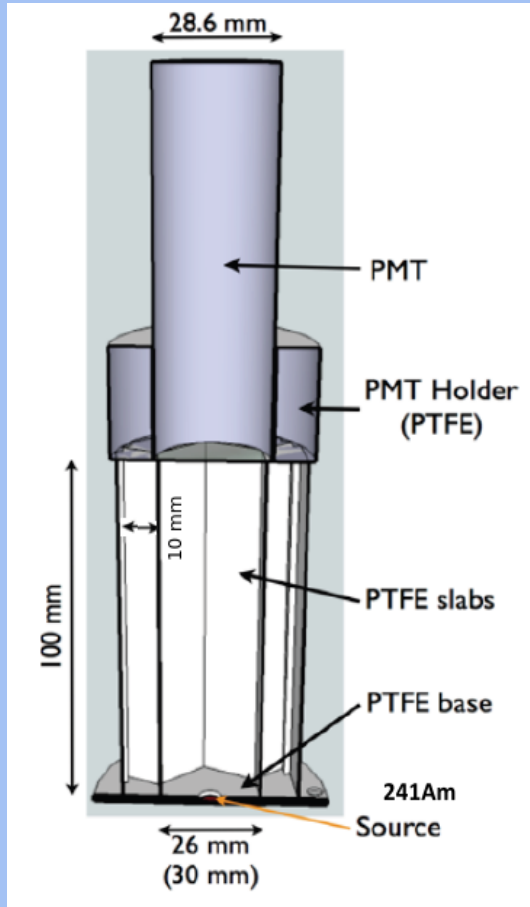
# LIP involvement

- **PTFE reflectivity measurement**
  - Provide a reference value for simulations
  - Choose the best batch to use in LZ
- **Slow control**
  - Coordination
  - Hardware for temperature monitoring (A.Bernardino, master project)
- **PMT array optimization**
  - Optimize PMT number and placement
  - Calculate expected position resolution and leakage into fiducial volume

# PTFE reflectivity: Motivation

- PTFE reflectivity is crucial for energy threshold and discrimination
- LZ requirement is  $>95\%$ 
  - LUX results suggest that even higher values are possible
- Coimbra is measuring LUX PTFE to
  - confirm LUX values independently
  - assess the accuracy of our method for LZ samples

# PTFE: Method and Results





# Slow Control: estimated channel count

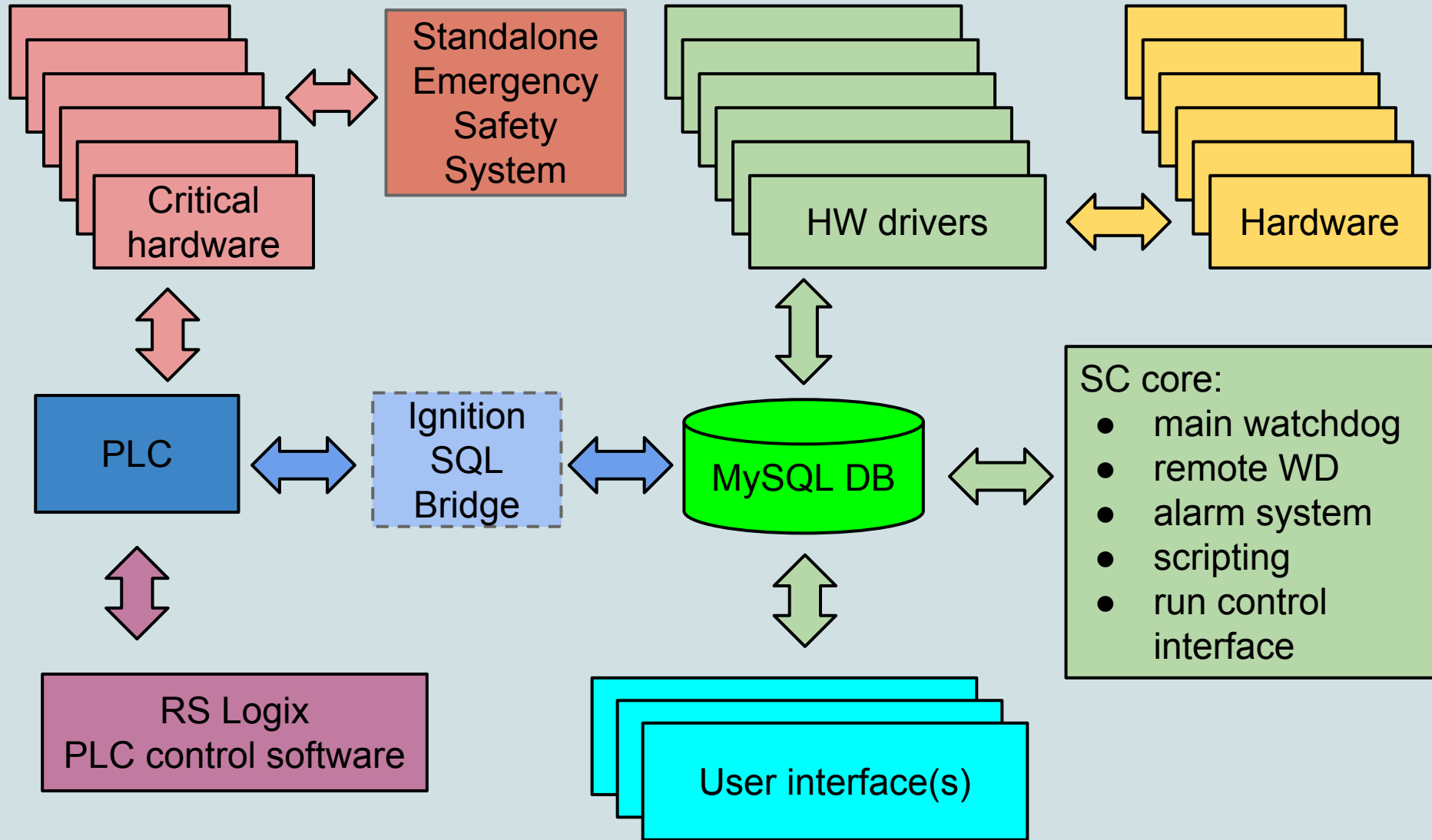
WBS		RTD	Analog In	Digital In	Relay	Serial	Ethernet
1.3	LN system	20	14	10	10	21	14
1.4	Gas system					12	
1.4.1	Sampling	12	8	24	24	14	4
1.4.2	Kr removal	25	38	75	75	17	12
1.4.4	Delivery and recovery	30	23	12	12	31	4
1.4.5	Recirculation and purification	18	25	28	28	12	4
1.4.6	Liquid purification tower	20				10	
1.5	Detector		5			5	6
1.5.5	Xe system monitoring	100				10	
1.6	Veto	20	20				
1.7	Calibration		4	10	10	8	
1.8	DAQ and electronics	36	182			10	40
	Environment	40	10	10		5	5
	<b>Total</b>	<b>321</b>	<b>331</b>	<b>169</b>	<b>159</b>	<b>155</b>	<b>89</b>

**Grand total:**

- **990** I/O channels
- **244** communication channels

**Approximately  
LUX x 2**

# Slow Control: Hybrid platform



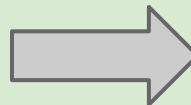
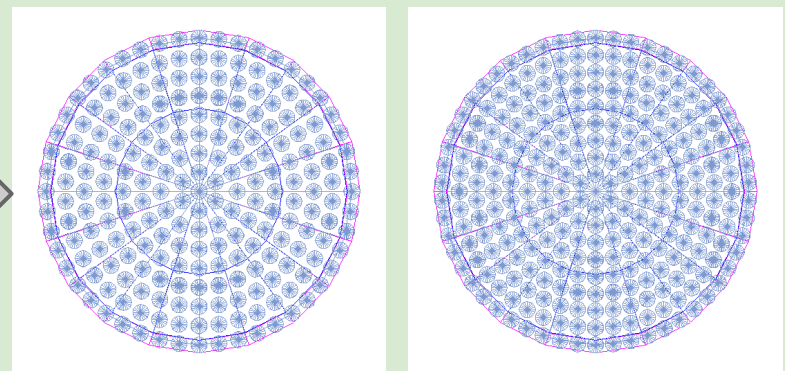
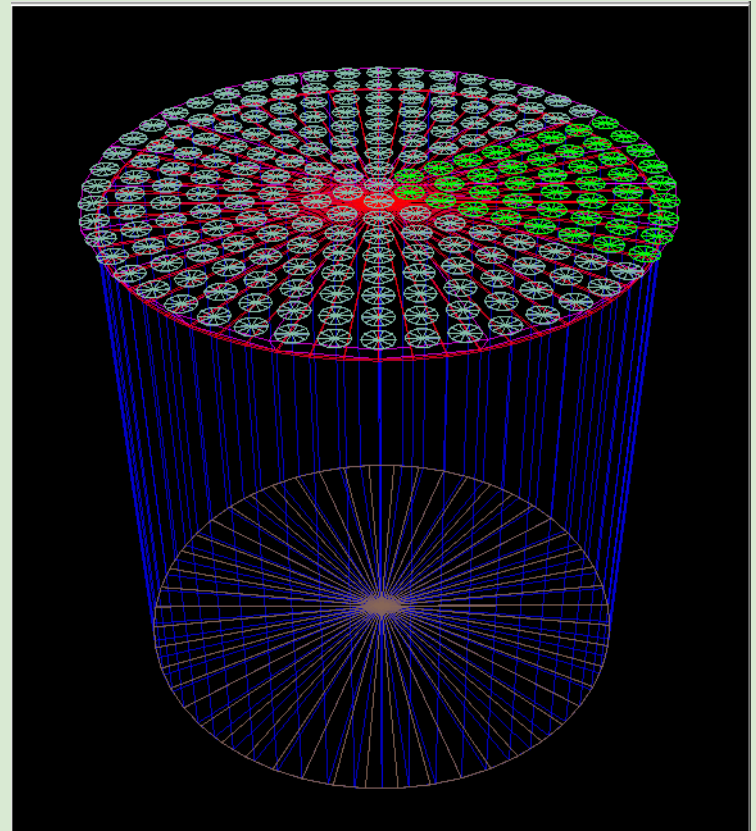
# PMT: Set-up & parameter space

## Simple model of LZ:

- $R=728$  mm
- $H(\text{LXe}) = 1450$  mm
- 3'' PMT on top (last ring overhangs detector wall by 1.5'')
- PTFE in gas: 80% in  $2\pi$
- PTFE in liq.: 96% in  $2\pi$
- LXe:
  - $n = 1.7$
  - $Latt = 30\text{m}$

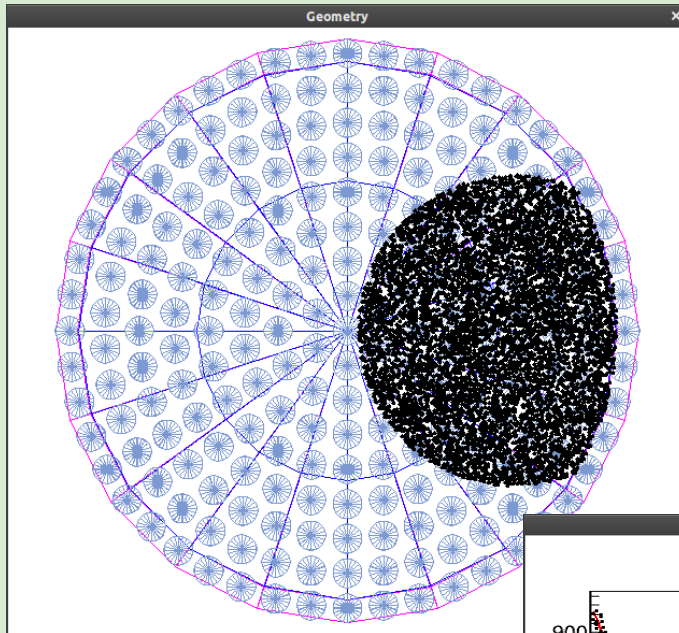
## What to be optimized:

- PMT - Anode plane distance
  - varied between 30 and 80 mm
- Wall reflectivity in gas phase
  - High (80%) and Low (0%)
- Number of PMTs in the top array
  - 217 or 271

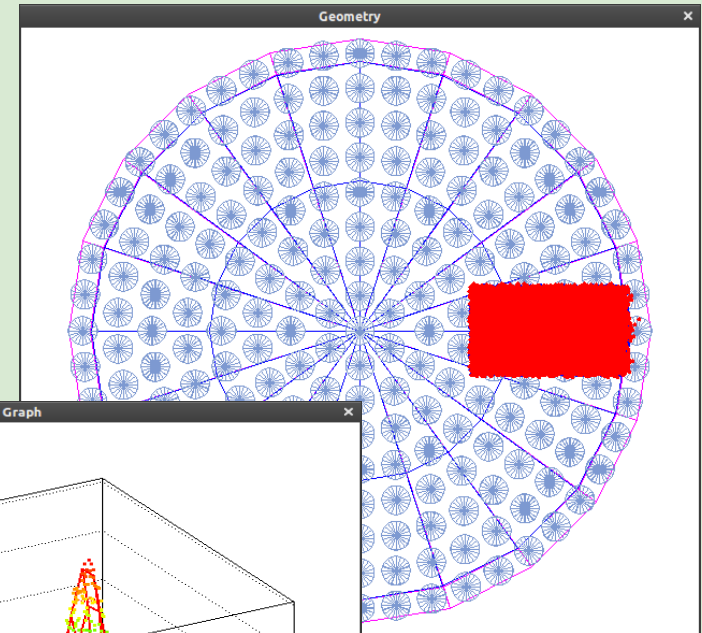


# PMT: ANTS II simulation

Generate photon bombs

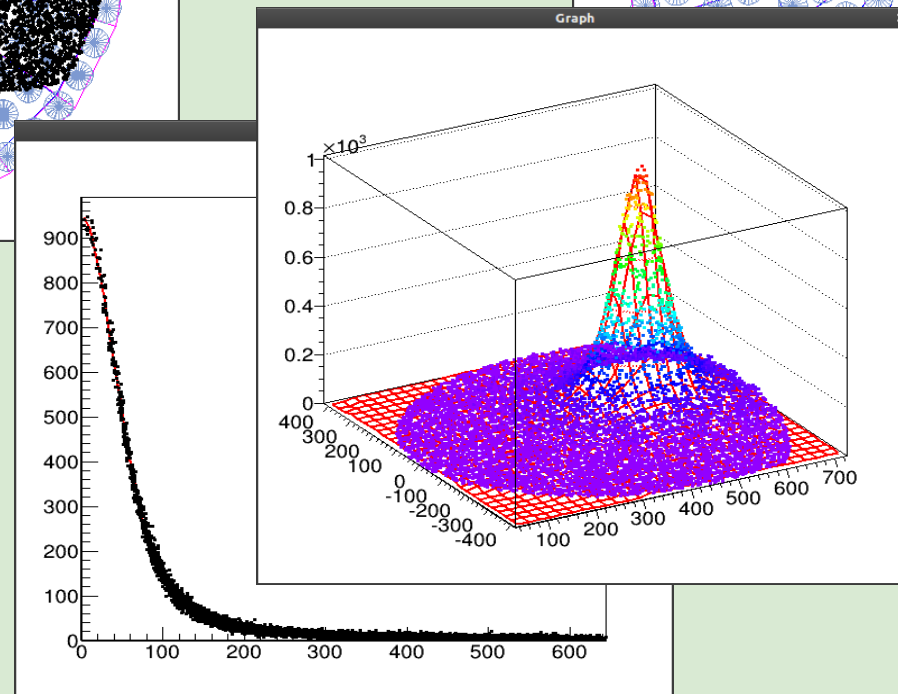


LS/ML reconstruction



Create LRFs

- in the middle of S2 region
- 10000 ph/bomb
- 10000 bombs
- flood-field over the active region



3 unknowns:  
x, y, energy

Initial guess:  
centroid

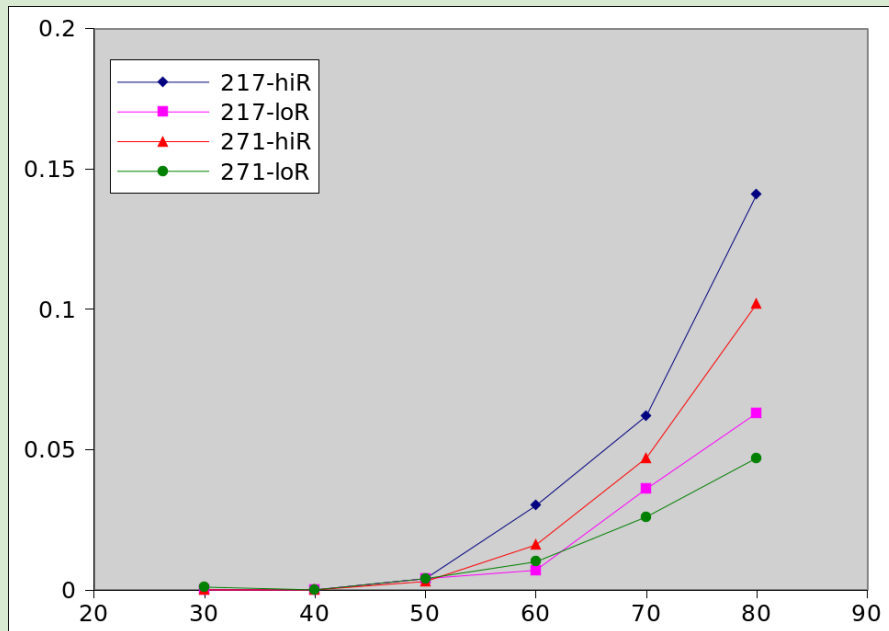
Individual LRFs, axially symmetric

# PMT: main results

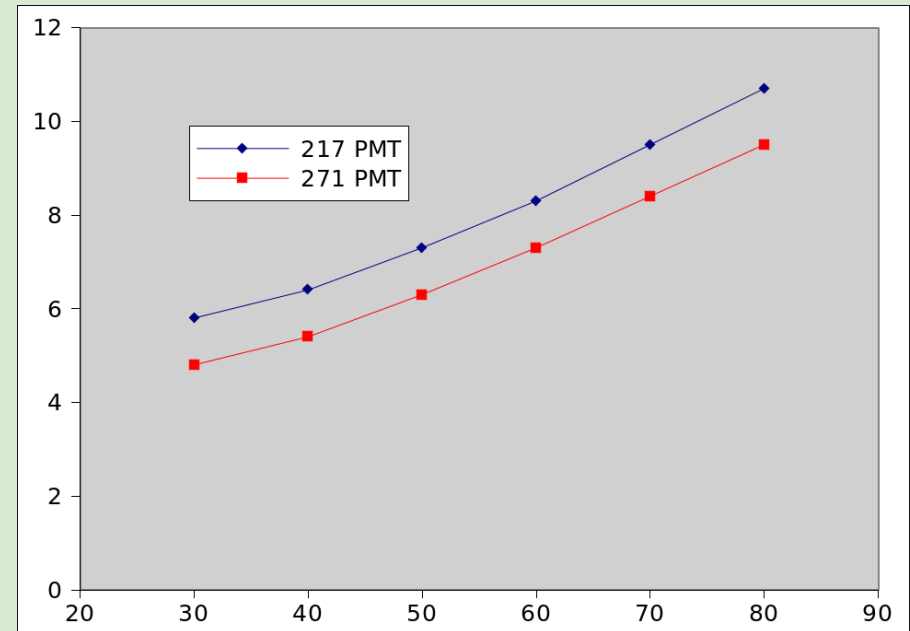
2500 photons per event  
( $100 < N_{pe} < 175$ )

**Leakage from outer layer  
( $R > 720\text{mm}$ )**

**RMS of reconstructed  
position, mm**



PMT - anode plane distance, mm



PMT - anode plane distance, mm